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AESTHETIC AND EMOTIONAL APPRAISAL OF THE SEATTLE PUBLIC LIBRARY AND ITS RELATION TO SPATIAL CONFIGURATION

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Abstract

How does the spatial configuration of a building influence aesthetic appraisal and emotion? Previous studies on wayfinding have included studying the effects of spatial layout and complexity, visual access, and the degree of spatial differentiation on users' cognition and wayfinding behavior, yet have rarely assessed the user's aesthetic and emotional evaluation of a building. Space syntax methods have been widely used for quantification, e.g., of how socially integrated and how navigable space is and complemented by behavioral data, and information about users' individual wayfinding strategies and cognitive abilities, space syntax has been a strong analytical tool in wayfinding studies. It is an open question to what degree the space syntax methodology can also capture aesthetic judgments or the emotional impact of a public building on visitors and inhabitants. These aspects of a building's impact are clearly relevant for design research and practitioners alike and research data is necessary to develop the corresponding discourse.

This paper contributes a set of qualitative data on subjective user evaluations from a wayfinding study in the Seattle Public Library to support the ongoing dialogue between the space syntax community and cognitive scientists. The building was selected because it has previously been subject to research (e.g., Dalton, Kuliga & Hoelscher, 2013; Zook & Bafna, 2012, Dovey & Dovey, 2009), and received both high praise and strong criticism, which illustrates the buildings' value as a research site.

In this study, participants selected six out of 76 adjectives from an adjusted version of the Microsoft Product Reaction Card Desirability Toolkit that, in their opinions, best described the Seattle Public Library. In a semi-structured interview, participants were further encouraged to verbally reflect on the experience they had during six wayfinding tasks in the Seattle Public Library, to describe their wayfinding difficulties, and to elaborate on the adjectives chosen from the reaction card task. A standardized questionnaire assessed their aesthetic and emotional appraisal in terms of general evaluation, attractiveness, security, and privacy for key locations in the library (entrance levels and meeting rooms) and the library as a whole.

Participants chose adjectives such as impressive, creative, stimulating, and innovative to describe their experience in the library, but also inconsistent, overwhelming, frustrating, intimidating, and stressful. This paper aims to develop an understanding of how these two clusters of mixed user opinions are related to the building's spatial structure. A visibility graph analysis (VGA) was conducted to identify where and how difficulties in understanding the library's unconventional circulation arise for library visitors. This paper makes a contribution to the field by suggesting methods for linking qualitative, and often highly emotive, data to objective spatial analysis.

Keywords: wayfinding, aesthetics, spatial analysis, perception, library

Theme: Spatial Cognition and Behaviours

Introduction

Space syntax quantifies inhabited space by examining its spatial configuration and social meaning and is a good predictor of human movement patterns, particularly for predicting user's free exploration and search for destinations in a yet unknown environment (e.g., Haq & Zimring, 2003; Hoelscher, Broesamle & Vrachliotis, 2009). But to what extent do building users directly perceive 'spatial configuration,' rather than forming a holistic impression, that includes, but is not limited to, specific views, unimpeded lines of sight and occupiable spaces; enriched by sensory input (e.g. from colors and materials) which, together, form a user's subjective experience of the surrounding environment?

From a psychological point of view, human-environment interaction has been discussed in terms of evolutionary-based subconscious preferences for certain, specific spatial configurations; e.g. space as provider of shelter and protection (enclosure) or facilitated orientation (prospect) (Appleton, 1988); or in terms of intrinsic human needs for environmental understanding and exploration (Kaplan & Kaplan, 1989) relating to environmental characteristics, such as a degree of complexity (informational richness), legibility (ease of identification of environmental elements), coherence (sense of order and organization), and mystery (promise that further information is available as one moves further into the scene). Applying these concepts to a virtual, indoor environment and asking participants to find the best indoor outlook or the best refuge place, Wiener and Franz (2004) found that *eye-level* views through a space can not only influence participant's behavioral judgments of indoor sites, but also correlates with their spatial experience in terms of perceived complexity, interestingness and clarity of the environment.

In 2012, Zook and Bafna raised the question of whether space syntax methodologies could be extended towards the phenomenal impression and imaginative experience that buildings can arguably evoke. Taking the Seattle Public Library as case study, they calculated isovist connectivity, integration and maximum radials to infer what phenomenal aspects users might possibly experience while pursuing library-typical tasks, such as checking out a book, attending a meeting, and meeting a friend to work together. Furthermore, Zook and Bafna cognitively walked along each of the presumed routes and presented a personal description of the phenomenal and visual experience of the building, describing possible vistas, colors, surfaces and materials. Zook and Bafna argued that the Seattle Public Library "*sets up an absorbing imaginative experience that decenters the visitor and excites exploration*" (p. 8087:1), but noted that their study's key limitation was the lack of actual user data.

This paper seeks to contribute a set of subjective spatial experience data (which has been gathered as part of a larger, extensive wayfinding study) to this ongoing discussion between the space syntax community and spatial and environmental researchers.

The Seattle Public Library

Designed by Loschky, Marquardt & Nesholm, and the Office for Metropolitan Architecture, the Seattle Public Library, WA, USA, was completed in 2004, and consists of eleven floors that, enveloped in a diamond-shaped glass and steel skin, clustered into various functional units, such as a floor for information, administration and media ("*Mixing Chamber*"), five floors of a continuous ramp for browsing and reading books ("*Book Spiral*"), a public space for reading, drinking coffee or attending events in an auditorium ("*Living Room*"), a whole floor of meeting rooms, a children's collection, foreign language collection, two staff-only floors, and a basement garage.

Surrounded by an eccentric exterior shape, the inside of the building sets up a vibrant tone with neon escalators, black boxes that hide staircases, quasi-theatrical lighting, modern furniture and carpets with macro-prints of plants, wild angled views of the outer structure, and dizzying heights when one looks down from the tenth floor to the atrium. Possibly due to its at times bewildering and cognitively complex design, the building received divided feedback by the public: *Voted Time Magazine's Building of the Year* in 2004 (Lacayo, 2004), and awarded with the *American Institute of Architects Honor Award for Architecture* in 2005 (Architecture Week, 2005), the library was also criticized for functional and navigational flaws. Shortly after the opening, local media commented that people were getting lost too often and that some parts of the building resembled a labyrinth (Murakami, 2006). To assist library users in finding escalators, stairs and restrooms, temporary posters with directions were installed to overcome the effects of missing signage and, before long, a professional wayfinding company (Wayworks, no date) was hired to install a new signage system. Bright-yellow directories now provide a global overview of the floors and their local functions, and blue free-standing columns offer directions to local destinations. The previously designed super-graphics on the undersurface of escalators and fronts of information desks remained as augmented artwork.

Nevertheless, critics did not wait long to call for a reassessment of the library, a post-occupancy evaluation that would not only address the functional limitations of the building, but, according to one journalist, also *"a region few architects know how to talk about: how a building feels. This one feels, in varying places, raw, confusing, impersonal, uncomfortable, oppressive, theatrical and exhilarating. Ponder any spot in this vast building, and two, three or more of those adjectives inevitably swirl together"* (Cheek, 2007).

Research indeed suggests that architects cannot, or only inaccurately, predict user's aesthetic reactions to particular buildings (Brown & Gifford, 2001). Furthermore, while architects appreciate the use of concrete (for example for its potential for sculpting), non-architects do not share this perspective and rate concrete mainly by visual impressions (Benz & Rambow, 2011). The question of how users experience a building is therefore nontrivial to design researchers and practitioners. As Thiel noted, *"we [design professionals] will certainly thrill to the poetic, practical, and proleptic fruits of our imagination. But [...] with their wonderfully various backgrounds, manifold preoccupations, and differing situations, will they [the users] – and should they- respond as we do?"* (Thiel, 1997, p. 36).

Research Questions

The research questions for this study were formulated as: 1) how do users describe their appraisal of key locations of the Seattle Public Library (e.g. what words do they use and which topics do they address?) and what difficulties for functionality of the building do they identify (e.g. where and how do difficulties in understanding the library's unconventional circulation arise for library visitors?); and 2) to what extent do configurational measures such as isovist area, connectivity and integration correspond with user statements (e.g. is there a measure of spatial configuration that could explain why certain locations are found troubling by users)?

Methods

Participants

36 Participants (18 males, 18 females) were recruited via a local online advertisement and received a compensation of \$30 for this two-hour-study. Participants were 18-61 years old

($M=30.39$, $SD=10.59$), and one-third of them ($n=11$) were 20-25 years old. Almost all participants were US-American ($n=31$) and all participants spoke English fluently. Three participants were students; the remaining participants worked in finances/accounting, creative businesses, or social and educative fields of work. Although the advertisement specifically invited people who had never been to the Seattle Public library, only half of the sample reported that they visited the building for the first ($n=4$, 11%) or second time ($n=11$, 30%) in their lives. Most participants had visited the library three to six times ($n=13$, 32%). Three participants who had visited the building 10, 30 and 120 times respectively were excluded from further analyses, leaving a sample of 33 participants. On a six-point scale, only two persons (6% of the sample) felt very or highly familiar with the building; three others felt neither familiar nor unfamiliar with the library (9%), and the remaining participants ($n=28$, 84%) did not feel familiar with the building. The distribution for how familiar participants felt with the architecture of the library was similar.

Materials and Design

In order to approach the first research question and assess user impressions of the Seattle Public Library, this study made use of six navigation tasks, along with participants' ratings on a questionnaire about environmental appraisal and a reaction card task, and their verbal comments about the building and its floors during a semi-structured interview.

Navigation Tasks in the library

The behavioral outcomes from the navigation exercises are part of an article in preparation, and are only used as context for the qualitative user data. The tasks were specifically designed to address specific task-oriented goals typical library users might have in the library, such as finding a certain book, media or a specific collection; finding a meeting room; finding the music practice rooms; and finding the restroom for children. For each task, participants were informed that the destination would be either on the same floor as the starting point (*within-floors*) or could only be reached via a change of floors (*between-floors*). Multiple paths to the destination were possible, and participants were instructed to find the shortest way. They were not allowed to use the elevators or talk to other library visitors or staff, and the maximum time for task completion was ten minutes. The researcher traced participants' navigation behavior with a developer's version of the Apple iPad application *PeopleWatcher* (Dalton & Dalton; Dalton, Dalton, KuhnMünch & Hoelscher, 2012) that was developed for real-time recording of human navigational behavior, such as navigating, pausing, or looking at signs. There was no interaction with the researcher, except when participants stated that they were lost or wanted to hear the task instruction again.

Questionnaire for Environmental Appraisal

'Aesthetic and emotional experience' has been discussed as "*cognitive and emotional processes evoked by the aesthetic processing of an object*" (Leder et al, 2004), or as a "*special state of mind that is qualitatively different from the everyday experience*" (Markovic, 2012). In this study, environmental appraisal was assessed via a standardized questionnaire by De Kort et al (2003) with 27 bipolar adjective six-point intervals on a semantically differential scale (e.g., "meaningless-impressive"). The questionnaire was extended by nine additional items provided by the researcher that were intended to be relatable to space syntax measures and terms from environmental psychology ("unstable-stable," "functional-nonfunctional," "confusing-comprehensible," "narrow-spacious," "simple-complex," "unclear-clear," "mystifying- clearly defined," "arousing-calming," "novel-familiar"). Participants could also provide free-text comments for each location.

The questionnaire aimed at rating the key floors levels of the library (the two entrance levels, the meeting rooms and book spiral), instead of all eleven floors separately, due to the restricted time frame of the study. In the final part of the questionnaire, participants were encouraged to rate the whole library as they had experienced it during the study, and to what extent viewing the outside structure of the building had given them an understanding of the geometry and building structure once they were inside the building.

Reaction Card Task

An alternative to measuring usability via a questionnaire is the "Product Reaction Card Desirability Toolkit" developed by the Microsoft Corporation in 2002. It consists of 118 "product reaction cards" with words such as *creative*, *gets in the way* and *flexible* (Benedek & Miner, 2002). Following instructions for subsamples of this test, the authors selected 76 positive and negative words that, in their opinion, had the potential to describe building characteristics (Figure 1). This set has successfully been used for other projects that aimed at building evaluation (Bartle, unpublished).

According to Barnum and Palmer (2010), the toolkit can "*prompt users to tell a rich and revealing story of their experience*" (p. 4703), which was deemed useful for this study, as it provided participants with a wider vocabulary to describe their experiences in the library.



Figure 1: Alphabetically-sorted 76-word Subset for Reaction Card Task.

One method to approach what words participants chose from the card sorting task and whether there was a trend of common words that all participants chose is the use of word clouds. Following McNaught and Lam's definition (2010), "*a word cloud is a special visualization of text in which the more frequently used words are effectively highlighted by occupying more prominence in the representation*" (p. 630). These "*wordles*" appear to be especially useful when they are supplemented with other research data (McNaught & Lam, 2010; Williams, Parkes, & Davies, 2011), and are transformed into a "*meaningful state*" first (Ramsden & Bate, unpublished), e.g. by analyzing positive and negative feedback separately (Williams et al, 2011). While several programs are freely available online, the authors used "Wordle.net," a web-based tool for visualizing text (Viégas, Wattenberg, & Feinberg, 2009).

Semi-Structured Interview

After participants had filled out the questionnaires, they were asked to think back to each task and elaborate how they had oriented themselves to find the destination and where they thought navigation was difficult. These comments were used as supplementary data to assess how users subjectively perceived certain areas. Due to library-restrictions, participants were not allowed to verbalize their experience directly while navigating ("thinking aloud"); however, retrospective reports immediately after a task and with a retrieval cue can give an approximation to actual memory structures (Ericsson & Simon, 1985). Therefore, photographs of the key locations were shown as an 'anchor' for a short time before they were turned upside-down (Figure 2).

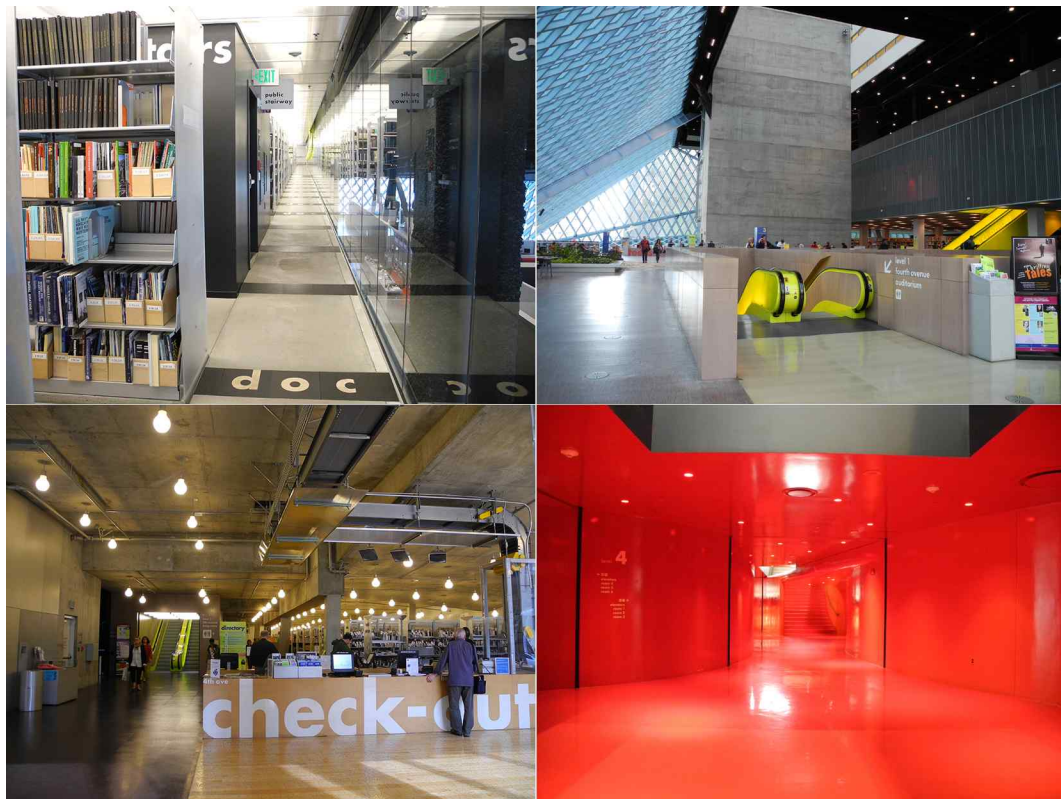


Figure 2: Photographs used as an 'Anchor' during the Questionnaire Procedure.

Participants were randomly assigned to a chained order of the six predefined navigation tasks, and could choose their paths freely while the researcher traced their navigation behavior using the *PeopleWatcher* iPad application. After completing all six navigation tasks, participants received the set of questionnaires for environmental evaluation in a nearby café. For the reaction card task, the cards were spread out in a random pattern on a separate table and each participant was asked to choose the six adjectives that, in their opinion, would best describe the Seattle Public Library. They returned to their table and were encouraged to place the words in a descending order from describing the building best to least well. This served as basis for the semi-structured interview about the tasks and the library, which rounded up the study.

Data Analyses

Because a Shapiro-Wilk test of normality revealed a skewed distribution to the extremes of the 6-point interval Likert scale for the four key areas ($df=33$, $p<.05$), unless reported otherwise,

non-parametric Friedman tests and Wilcoxon tests ($df=4$) with Bonferroni corrections were used to assess whether the ratings of the areas differed significantly within the sample of 33 participants. Pearson correlation coefficient and Spearman rank correlation coefficient Rho were conducted for the syntactic variables and six exemplary items that were selected as subset based on a greatest variance and significant difference between the locations. Furthermore, participants' verbal and text data were sorted by key location (e.g. third floor) and content (e.g. orientation, navigation and signage) and linked to the statistical outcomes of the questionnaire (e.g. *narrow-spacious*). For the reaction card task data, "wordles" (see earlier) were created and participants' elaborative comments about these words were used for interpretation.

Results

Questionnaire and Participants' Free-text Answers

First Floor Entrance

When participants thought back to the first floor, they felt that it was most open of all rated sections (Wilcoxon-test $df=3$, Bonferroni-correction $p<.008$; $M=5.47$, $SD=.92$), quite spacious ($M=4.88$, $SD=1.01$), *stable* ($M=5.19$, $SD=.84$); and *more functional* ($M=5.15$, $SD=.89$) than the meeting rooms ($M=4.29$, $SD=1.51$; Bonferroni-correction $p<.01$). The floor was also perceived as safer ($M=5.12$, $SD=.94$) than the meeting rooms ($M=4.35$, $SD=1.57$, $p<.01$), which can probably be attributed to the security checkpoint in this section. The floor felt more *public* than private ($M=1.69$, $SD=.98$), *legible* ($M=5.03$, $SD=.96$) and *accessible* ($M=4.88$, $SD=.96$), although less accessible than the third floor ($M=5.44$, $SD=.61$, $p<.01$). Participants' opinions on attractiveness diverged, but some mentioned it was their least favorite floor because of the concrete; *"it feels more like a parking garage."*

Third Floor Entrance

This area was rated as the most impressive of all key locations ($M=5.18$, $SD=.79$, $p<.01$), except the meeting rooms ($M=5.26$, $SD=.89$). It felt more inviting ($M=4.74$, $SD=.83$) than the first floor ($M=4.00$, $SD=.12$; $p<.01$); was most *attractive* of all rooms ($M=4.82$, $SD=.94$; $p<.01$); and quite *pleasant* ($M=4.88$, $SD=.88$; *"great window views!"*). The concrete elevator shaft was both loved (*"I love the centre column contrasting the slanted windows"*) and hated (*"the glass makes it much more beautiful; still too much concrete and the color is ugly"*). The area was further perceived as *safe* ($M=5.18$, $SD=.72$) and *functional* ($M=5.12$, $SD=.84$).

Book Spiral

Participants commented: *"Confusing - I'm still unclear as to the easiest way to traverse the stairways,"* and even more negative: *"I got dizzy and lost."* They felt that the book spiral was the *narrowest* section in the library (Bonferroni-correction $p<.008$, $M=1.97$, $SD=1.41$); most *closed* of all rooms ($M=2.26$, $SD=1.07$, $p<.008$); more *monotone* than the first and third floors ($M=2.71$, $SD=1.33$, $p<.001$); and most bare in terms of decoration ($M=2.65$, $SD=1.09$; $p<.01$; *"I like the shelves and being able to see some wood; the concrete still feels kind of industrial"*). The spiral was also judged, without further context, as *"a little frustrating."*

Meeting Rooms

This all-red floor led participants to comment in a more emotive manner; in one case revolted (*"what? I never want to go back there!"*), in another devoted (*"I love the 4th floor-red meeting rooms"*). The color was highly criticized by many participants; e.g. *"red is not a calming or soothing color;"* *"monotone red is intimidating;"* *"overwhelming, unpleasant, too red;"* and *"hideous red, very dark overall impression; narrow hallway when doors open out into it."* This comment referred to a staircase that had been designed as emergency exit, but was later

opened for public use due to navigational issues. Two participants found analogies: *"it made me feel like I was a little kid again, trying to walk through those tubes,"* and *"I felt like I was inside building blocks or a toy."* Participants judged the meeting rooms as equally impressive as the third floor ($M=5.26$, $SD=.89$), and *most interesting* of all rooms except the first floor ($M=5.21$, $SD=.98$, Bonferroni-correction $p<.008$). Although opinions were divided, the meeting room floor was also rated as *most arousing* ($M=2.65$, $SD=1.41$; $p<.01$), *most artificial* ($M=1.88$, $SD=1.27$; $p<.01$), and *most mystifying of all rooms* ($M=2.91$, $SD=1.44$; $p<.008$); and, similar to the book spiral, the *most monotone area* ($M=2.35$, $SD=1.53$; $p<.01$); *bare* ($M=2.88$, $SD=1.66$) and *closed* ($M=2.91$, $SD=1.24$).

Whole Library

In general, seven participants (21% of this sample) stated that viewing the outside structure of the building had given them an understanding of the geometry once they were inside the building; 23 persons felt that viewing the exterior did not help (70%), and three participants (9%) did not report an opinion. To most participants, the interior felt quite impressive ($M=5.33$, $SD=.98$). While some users appreciated the buildings' complexity ($M=4.94$, $SD=1.09$; *"amazing, I had no idea it was so complex"*); other users criticized this aspect (*"I was surprised how non-intuitive it was for me to find my way"*). Signage and spatial differentiation were also mentioned as critical factors (e.g., *"it [was] hard to form a cohesive picture of the library and its layout in my head. - Extremely interesting to walk through, but it does make it difficult to find things."*)

On an aesthetic note, most, but not all, participants found the library *attractive* ($M=4.81$, $SD=1.11$), *pleasant* ($M=4.83$, $SD=1.03$), *tasteful* ($M=4.81$, $SD=1.03$), and *interesting* ($M=5.33$, $SD=.71$). The building felt open ($M=5.03$, $SD=.87$) and *light* ($M=4.97$, $SD=.97$). It could be observed that some participants strongly liked certain aspects of the building, but strongly disliked others (e.g., *"I really love all the areas with glass, natural lighting, carpets and plants; like the 3rd floor or the top floor. But I dislike all the concrete areas and the loud colors, and especially the escalator decorations"*). Some participants appeared to experience a tension between aesthetics and functionality: *"Overall it's a beautiful library, but it takes getting used to. I enjoy exploring new spaces, so I have fun figuring out the layout on my own."* Yet others felt that the library was built from a *"very strange architecture, not user friendly for a first time visitor,"* and that the circulation was *"confusing, but okay if you go with the flow."*

Reaction Card Task

The six words that participants selected that in their opinion would describe the Seattle Public Library best were visualized for positive (70 %) and negative feedback (30%) separately (Figure 3). Nine participants (25%) chose solely positive words and two participants (5%) chose solely negative words; in all other cases feedback was mixed, e.g. participants found that the library was *innovative*, but also *confusing*.



Participants were also asked to verbally elaborate on why they had chosen the words to assess the tone participants had attributed to the word. For example, *unconventional* was interpreted positively; e.g. noting that floors were different, staircases would lead to different levels, and unexpected vistas would emerge. Participants also perceived looking down from the highest point on floor ten towards level three as giving them a better understanding of the structure of the library (in reality, this view provided few clues to the general layout of the building). Participants chose innovative because the library felt more sophisticated and creative than traditional libraries. The size of the library was the main reason participants chose the word impressive. The building felt stimulating and creative; "it makes your mind work on a different level. Neon green and red [is] more awakening than most buildings." The words attractive and cutting-edge also referred to colors, angles, and the exterior "shell." Participants felt that the compelling building stimulated an active approach; e.g. "it made me really curious to see what's going on throughout the whole thing;" and "[it] begs to be explored." The unconventional layout was "thought-provoking. I actually feel like there was more relational involvement in this building than in other buildings. This one had a lot more character and interaction."

Semi-Structured Interview

Orientation, Navigation and Signage

Participants generally reported a positive aesthetic experience, but uncomfortable navigation; for example, they pointed out that the staircases were clearly labeled, but located at unexpected locations; escalators surprisingly skipped whole floors, and participants missed a *"central location for all floors to get from one floor to the next"* (which was the original function the architects had assigned to the "Mixing Chamber"). "Going up" the building felt easy, but "going down" remained unclear, because there was no down-escalator and the staircases were not always visible. It also was *"intimidating"* that the floors were all different; *"almost like a maze."* The book spiral was especially difficult to understand, *"because I went up those stairs and I thought that would be a whole another level;"* it felt *"cluttered, uneven and unpredictable;"* *"winding around like an accordion"*.

To find the destinations for the wayfinding tasks, participants reportedly followed signs and used directories, tried to first find the correct floor, or simply explored space by *"wandering around"* until the correct destination was found. Participants complained that the signage felt *illogical, unfamiliar and confusing* (*"I was very surprised today that it wasn't more obvious how it works"*); missed details, and the arrows on the blue columns and the maps provided on third floor did not help. Furthermore, exits and entrances did not appear clearly defined and the library felt like a *"space that has a lot of different spaces within it."* Noting that she never felt any sense of orientation in the building, one participant believed that wayfinding would be easier if visitors spent more time reading the signs and super-graphics instead of *"breezing past, trying to figure the way out on their own."*

Aesthetics and Emotion

Many participants appreciated the building's design and intended to return later to explore the building further. Some perceived a tension when asked to rate the library, because everything felt extreme to them. On the rather emotive side of the ratings, some participants stated that they had perceived the library as *daunting, intimidating and claustrophobic*.

From an aesthetic point of view, the use of concrete was generally disliked for being sterile and cold. One participant remembered *"bright lime green, red, pink, and huge rooms with windows and views, both to the skyscrapers around and the town below,"* while another saw *"either concrete, or one color"*. From this statement and the general tone of several others, one could argue that by its unconventional design, the library evokes a tension between functionality and aesthetics that some participants appreciate: *"the planning of the building is weird; you get going in circles; up on floors you've been on. But that makes it kind of cool also!"* Another participant felt a void between *exploration and functionality*, because the building felt so *highly artistic and expressive* that it would hinder the accomplishment of tasks. Exploration and functionality, according to him, *"don't seem entirely integrated, although they do coincide and help each other out."*

Subset of Questionnaire Items

In summary, the general tone of the questionnaire, reaction card task and interview data appeared to reveal quite mixed user opinions about the library. In order to develop an understanding of how these user opinions could be related to the building's spatial structure, a detailed Visibility Graph Analysis (VGA) and Convex Space Analysis was conducted, and a subset of six questionnaire items that showed the highest variance in user ratings and significantly differed between library areas (Figure 4) was used for subsequent correlation analyses.

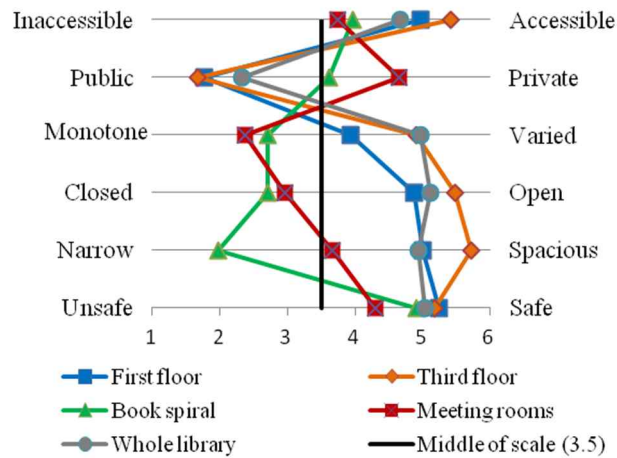


Figure 4: Subset of Six Questionnaire Items.

Space Syntax Analysis

The challenge of performing the space syntax analysis for this study was to select measures that could be used to define the spatial properties of specific point-locations, such as the first floor entrance, whilst also being used to measure the aggregate properties of larger regions, such as the book spiral. A combination of Convex Space Analysis, Visibility Graph Analysis (VGA) and Point Isovist Analysis was used.

A convex space breakup was performed for all public floors of the library. For each individual location (from which the “anchor” photographs were taken), the measures of convex space connectivity, mean depth, real relative asymmetry, relative asymmetry and total depth were calculated. For the larger regions, the average value was calculated for all the convex spaces constituting that region (Table 1).

A similar exercise was performed for isovists and visibility graph analyses (VGA): for the larger regions, a number of isovist points were selected and the average value for the entire set of points constituting the region was calculated and the configurational and geometric measures ‘mean isovist integration’, ‘mean isovist area’, ‘mean isovist connectivity’, ‘mean isovist visual control’ and ‘mean isovist maximum radial length’ were calculated. For the specific locations from which the photographs were taken, full 360° isovists and partial 120° isovists (most closely approximating the camera lens used) were generated (Table 1; partial isovists displayed in Figure 5). The Visibility Graph Analysis was produced using the Depthmap software (Turner 2001, 2004, & 2007).

Table 1: Results from Convex Space Analysis and Visibility Graph Analysis.

| Area | Convex Space Analysis (Larger Area) | | | | | Convex Space Analysis (Point of Photograph) | | | | |
|------------------------------|-------------------------------------|-------------------|---------------------------|-----------------------------|------------------------------------|--|----------------------|-------------------------|--------------------|-------------|
| | Mean Connectivity | Mean Depth | Real Relative Asymmetry | Relative Asymmetry | Total Depth | Connectivity | Mean Depth | Real Relative Asymmetry | Relative Asymmetry | Total Depth |
| First Floor Entrance (FFE) | 3.12 | 9.94 | 1.50 | 0.05 | 3677.86 | 3.00 | 7.74 | 1.13 | 0.04 | 2863 |
| Third Floor Entrance (TFE) | 3.10 | 8.82 | 1.30 | 0.04 | 3264.27 | 7.00 | 8.16 | 1.20 | 0.04 | 3018 |
| Meeting Room Floor (MR) | 3.09 | 8.72 | 1.29 | 0.04 | 3226.08 | 4.00 | 9.50 | 1.43 | 0.05 | 3533 |
| Whole Book Spiral (BS) | 3.16 | 8.84 | 1.31 | 0.04 | 3272.32 | 4.00 | 7.91 | 1.16 | 0.04 | 2927 |
| Area | VGA Analysis (Larger Area) | | | | | Point Isovist Analysis (Point of Photograph) | | | | |
| | Mean Integration | Mean Isovist Area | Mean Isovist Connectivity | Mean Isovist Visual Control | Mean Isovist Maximum Radial Length | Point Isovist Area | Partial Isovist Area | | | |
| First Floor Entrance (FFE) | 2.02 | 817.66 | 826.69 | 1.49 | 56.87 | 527.09 | 209.76 | | | |
| Third Floor Entrance (TFE) | 2.19 | 1590.50 | 1458.52 | 1.87 | 71.85 | 1852.86 | 1463.96 | | | |
| Meeting Room Floor (MR) | 1.91 | 253.86 | 251.73 | 1.01 | 28.43 | 244.99 | 213.06 | | | |
| Mixing Chamber (*not include | 2.52 | 1391.39 | 1415.65 | 1.01 | 59.95 | n/a | n/a | | | |
| Whole Book Spiral (BS) | 1.93 | 127.85 | 131.15 | 0.99 | 34.85 | 155.87 | 104.52 | | | |
| Tenth floor (*not included) | 2.01 | 1135.34 | 1101.87 | 1.01 | 51.99 | n/a | n/a | | | |
| The Whole Library | 1.98 | 476.00 | 474.85 | 1.00 | 39.74 | n/a | n/a | | | |

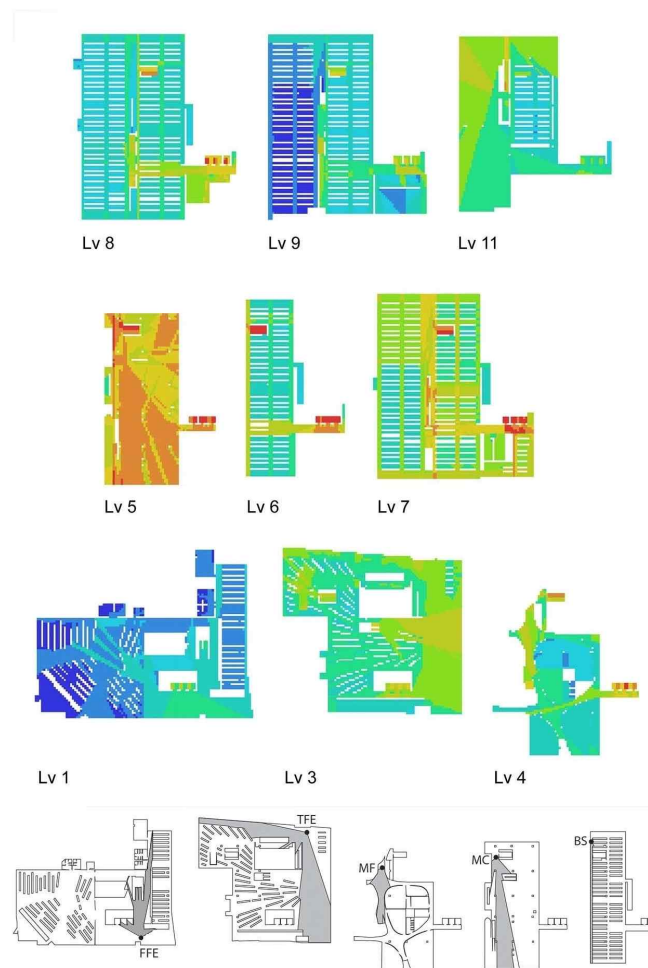


Figure 5: Above: Visibility Graph Analysis (VGA) for the Public Spaces of Seattle Public Library, Coloured by Isovist Integration (high=red, low=blue). Below: the Locations from which the Questionnaire Photographs were Taken and their Respective Partial Isovists.

Correlation Analyses

Pearson's correlation analysis revealed that the VGA-measures (except partial isovist with mean isovist connectivity, visual control and mean maximum radial length; and point isovist with mean maximum radial length; $<.89$, $p<.01$) correlated significantly among each other ($r>.95$, $p<.01$). The convex space measures (except convex connectivity with any other measure) were significantly inter-correlated at $p<.01$. The six subjective ratings correlated among each other at $p<.05$ (Table 2, upper part).

Table 2: Spearman-Rho Correlation Matrices.

| Spearman-Rho Correlations between Item-Subset Items | | | | | | | | | | | | |
|---|----------------|------|--------------------|------|----------------|------|--------------------|------|-------------------|------|----------------------------|------|
| | unsafe safe | | narrow spacious | | closed open | | monotone varied | | public private | | inaccessible accessible | |
| | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p |
| unsafe safe | 1.00 | n/a | .18 | <.05 | .31 | <.01 | .21 | <.05 | -.33 | <.01 | .34 | <.01 |
| narrow spacious | | | 1.00 | n/a | .75 | <.01 | .53 | <.01 | -.48 | <.01 | .46 | <.01 |
| closed open | | | | | 1.00 | n/a | .62 | <.01 | -.59 | <.01 | .53 | <.01 |
| monotone varied | | | | | | | 1.00 | n/a | -.45 | <.01 | .40 | <.01 |
| public private | | | | | | | | | 1.00 | n/a | -.58 | <.01 |
| inaccessible accessible | | | | | | | | | | | 1.00 | n/a |
| Spearman-Rho Correlations between Item-Subset and VGA-Measures (Area and Photo Point) | | | | | | | | | | | | |
| | unsafe safe | | narrow spacious | | closed open | | monotone varied | | public private | | inaccessible accessible | |
| | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p |
| Mean Isovist Integration | .19 | <.05 | .59 | <.01 | .70 | <.01 | .58 | <.01 | -.67 | <.01 | .52 | <.01 |
| Mean Isovist Area | .10 | .28 | .77 | <.01 | .73 | <.01 | .53 | <.01 | -.54 | <.01 | .49 | <.01 |
| Partial Isovist Area (Photograph Location) | -.05 | .61 | .61 | <.01 | .48 | <.01 | .33 | <.01 | -.19 | <.05 | .30 | <.01 |
| Spearman-Rho Correlations between Item-Subset and Convex Space Measures (Area) | | | | | | | | | | | | |
| | unsafe safe | | narrow spacious | | closed open | | monotone varied | | public private | | inaccessible accessible | |
| | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p |
| Mean Connectivity | -.12 | .18 | .22 | <.05 | .06 | .95 | -.12 | .16 | .19 | <.05 | -.09 | .32 |
| Mean Depth | .02 | .80 | .38 | <.01 | .26 | <.01 | .08 | .38 | -.18 | .05 | .11 | .22 |
| Relative Assymetry | .15 | .10 | .25 | <.01 | .29 | <.01 | .15 | .09 | -.38 | <.01 | .17 | <.05 |
| Spearman-Rho Correlations between Item-Subset and Convex Space Measures (Photo Point) | | | | | | | | | | | | |
| | unsafe safe | | narrow spacious | | closed open | | monotone varied | | public private | | inaccessible accessible | |
| | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p | r_s | p |
| Connectivity | -.05 | .54 | .19 | <.05 | .17 | .05 | .20 | <.05 | -.02 | .85 | .15 | .08 |
| Mean Depth | -.20 | <.05 | -.04 | <.05 | -.18 | <.05 | -.15 | .08 | .41 | <.01 | -.16 | .07 |

In order to assess the strength of association between the six-item subset (Figure 4) and the syntactical measures for convex spaces and isovists (Table 1), Pearson's correlation and nonparametric Spearman rank correlation Rho were computed and averaged over an aggregated larger region, and at the level of the partial isovist (photograph) location, respectively. As both Pearson and Spearman-Rho correlation analysis showed a similar correlation pattern, only the nonparametric Spearman-Rho's correlation coefficient is reported here, as it is more appropriate for rating data that is not normally distributed around the mean. The individual participant ratings of the four areas of each of the 33 participants were correlated with the syntactic measures; yielding N=132 data points.

Spearman Rho correlation analysis between the syntactic VGA-measures and the subjective participant ratings indicated that mean isovist integration and mean isovist area explained the largest proportion of the variance in participants' ratings of the four library regions (Table 2, middle). As mean isovist connectivity, mean isovist visual control and point isovist area did not explain additional variance in this sample's ratings with respect to mean isovist area; and mean isovist maximum radial length, in this sample, did not explain additional variance beyond mean

isovist integration (except weakly for safety perception), these variables were dropped from further analysis. These correlations appeared to form the following descriptive clusters: Mean isovist integration was the best predictor for how 'public' or 'private' participants rated the four locations ($r_s(131) = -.67, r^2 = .45, p < .01$); more highly integrated areas, such as the third floor, felt more public. Mean isovist integration further predicted how monotonous or varied space felt ($r_s(131) = .58, r^2 = .33, p < .01$); the less integrated meeting rooms and book spiral felt more monotonous and private. In addition, mean isovist integration modestly predicted how accessible participants rated the areas ($r_s(131) = .52, r^2 = .27, p < .01$); less integrated areas, such as the meeting rooms, felt less accessible. Accessibility was also strongly captured by mean isovist area ($r_s(131) = .49, r^2 = .24, p < .01$). Mean isovist area appeared to be the best predictor for how narrow or spacious ($r_s(131) = .77, r^2 = .59, p < .01$), and how closed or open ($r_s(131) = .73, r^2 = .53, p < .01$) space was perceived, as larger areas were rated safer and more open (spatial openness was also strongly captured by mean isovist integration, $r_s(131) = .70, r^2 = .49, p < .01$; more integrated areas felt less closed). Furthermore, mean isovist integration and mean maximum radial length correlated equally, but weakly, with how unsafe or safe areas felt ($r_s(131) = .19, r^2 = .04, p < .05$); with less integrated areas and shorter lines of sight being rated as less safe. Partial isovist area predicted how narrow or spacious ($r_s(131) = .61, r^2 = .37, p < .01$) and closed or open areas felt ($r(131) = .48, r^2 = .23, p < .01$), although less than mean isovist integration and mean isovist area. It also correlated with how monotone or varied ($r(131) = .33, r^2 = .11, p < .01$), accessible or inaccessible ($r(131) = .30, r^2 = .10, p < .01$), and, weakly, how public or private areas were perceived ($r(131) = -.19, r^2 = .04, p < .05$).

Spearman Rho Analysis between the convex space measures and the subjective participant ratings (Table 2, below) indicated weak correlations: Relative asymmetry (RA) correlated with how public or private participants rated the areas ($r_s(131) = -.38, r^2 = .14, p < .01$), as areas with lower relative asymmetry were rated more private. Mean depth, relative asymmetry and total depth were the best indicators for how narrow or spacious ($r_s(131) = -.38, r^2 = .14, p < .01$) and how closed or open ($r_s(131) = -.26, r^2 = .07, p < .01$) space was perceived, as deeper areas were rated more spacious and open. These variables showed similar correlation patterns, so only mean depth is reported here. For the anchor photograph location points, mean depth, real relative asymmetry, relative asymmetry and total depth also showed similar correlation patterns to how public or private a photograph location was perceived ($r_s(131) = .41, r^2 = .17, p < .01$), and convex connectivity correlated with how monotone or varied ($r_s(131) = .20, r^2 = .04, p < .05$), and how narrow or spacious ($r_s(131) = .18, r^2 = .03, p < .05$) areas were rated, while none of the other syntactic measures related to this particular rating scale. In general, the VGA-measures provided stronger explanations for the variance in participants' ratings for the four locations than the convex space measures.

Discussion and Conclusions

The current study has provided user comments about the Seattle Public Library in order to explore how building users describe their aesthetic and emotional judgments of the building, the locations where users identify difficulties in understanding the building, and to what extent space syntax measures correspond to user statements.

First, referring back to the journalist's statement in the introduction of this paper (Cheek, 2007), the study participants also appeared to perceive certain areas in the Seattle Public Library as *confusing, impersonal, and exhilarating*. However, this is not their whole story: while many participants felt a sense of confusion due to the library's complex, unconventional circulation, and unfamiliar and, at times, intimidating style, at the same time, many also adored the library's exceptional 'daring' architecture, its sheer spaciousness and its creative, stimulating design. The

study participants indeed felt that the circulation was unconventional in terms of the unexpected locations of staircases, bypassing escalators, absence of any down escalators, and a missing 'central' location, but they also experienced a curiosity to take an adventurous look and to explore the different floors further. These findings are in line with Zook and Bafna's (2012) theoretical argument that the library "*engenders sort of restlessness, a sense that things are happening somewhere nearby.*" As Markovic (2012) noted, aesthetic evaluation is a subjective, aroused state of fascination, appraisal and emotion, which, arguably, can lead to disorientation in space and time. As a result, aesthetic stimulation in the Seattle Public Library might get in the way of functionally accomplishing tasks, and instead excite a need for environmental understanding and exploration.

Second, this paper also aimed at developing an understanding to link qualitative and often highly emotive data, to objective spatial analysis. The seven spatial measures selected in general were able to account for a large proportion of the variance of six selected, subjective user ratings for the four locations and the whole library. This is a first indicator that the rather mixed user opinions about key locations in the Seattle Public Library are related to the building's spatial structure as quantified by space syntax. However, several items were included in the study based on the a-priori hypothesis that they should be spatial descriptions semantically related to the syntactic measures, such as "unstable-stable" or "illegible-legible". These did not differ significantly between the rooms, and this suggests that lay-users (neither architects nor space syntax researchers) rarely use these terms for describing spaces, or that they might use different criteria or concepts for environmental evaluation compared to architects, designers or researchers. Future research needs to examine the interconnections and generalizability of the current findings in more detail.

The success or failure of a building is not solely determined by constructional and functional issues, but mainly by how a building feels from a situated perspective and how users can act upon and interact effortlessly and intuitively with their environment. The aim of this article is not to judge whether the Seattle Public Library succeeds or fails as a building, but to provide user impressions and explore the link with objective space syntax data. While the building's aesthetics deeply impress many people (and a desire for environmental understanding and exploration could be part of the function of experiencing modern architecture), its unconventional circulation confuses people (which is potentially dysfunctional in a library); leading to an open question: what is the main goal of a building? As Le Corbusier noted, architecture as circulation is "*that symphony which we must experience [which] should not be revealed to us exclusively by functional considerations [...], but by emotional considerations; for the various aspects only become comprehensible gradually as we follow our wayward feet, moving hither and thither, with our eyes fixed on the walls and the perspectives, meeting expectedly or unexpectedly with doors which reveal the secret of new spaces*", and further: "*Organization must be seen in conjunction with the purpose of the building. Good architecture can be traversed both inside and out*" (Le Corbusier 1943, in Thiel, 1997, p. 37).

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